Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at http://about.jstor.org/participate-jstor/individuals/early-journal-content.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

BRIEFER ARTICLES.

PHYSIOLOGICAL NOTES. I.

1. Soja beans for imbibition experiments.

No seeds, unless they have been killed, are suitable for the demonstration of imbibition except when the experiment is to run for a short time, as for a single day. But for such brief experiments — and they are as good as longer ones — the Soja beans are an especially interesting subject, because of their pronounced change of shape in swelling. The three diameters may be designated as D, the longest one, passing between the cotyledons, at a right angle with D', which also passes between the cotyledons, but through the hilum, and D'', which passes through the cotyledons. The average lengths of these in ten air-dry beans were: D, 0.30734 inch; D', 0.28061 inch; D'', 0.22583 inch. After soaking twenty-four hours in distilled water at 14° C., the measurements were: D, 0.53708 inch; D', 0.34193 inch; D'', 0.2651 inch. The increase had been: D, 74.75 per cent., D', 21.85 per cent., D'', 17.39 per cent. I have never seen a change in shape comparable to this in the swelling of any other hard and solid substances. The swelling at first is more uniform in all directions, so far that D'' is occasionally greater when imbibition is a little over half complete than when it is finished (!), though the seed coats are not wrinkled when this occurs. The increase in bulk of these beans was very nearly 150 per cent., while the increase in weight was only 133 per cent. (the dry beans are very heavy).

Working on the micellar hypothesis, we expect the power to conduct heat in any direction to vary somewhat inversely to the power to absorb water: since the greatest swelling will be in the direction of the least axes of the micellae, where the proportion of surface to mass is greatest, while heat is conducted most easily lengthwise of the micellae, in the direction of fewest breaks. Thus heat travels most readily lengthwise in wood, at a right angle to the line of greatest swelling. I tested it with these beans by the usual method, melting a very thin layer of paraffin on the surface, and sticking a hot needle in the middle. On the smooth surfaces, where the cotyledons meet, the melted area is even in outline and easy to see. Average dimensions of ten such melted areas were: along axis *D*, 0.0649 inch; along *D′*, 0.0714 inch. The diameters of the cells which conduct the heat are about equal in these two directions. The cells are elongated along the axis *D″*, but the cotyledons cannot be cut so as to give a surface smooth enough to work with. The result — conduction more difficult in the direction of greater swelling — harmonizes with the hypothesis. But it is hard to imagine an arrangement of the micellae by which their long axes are, for instance, parallel in the entire cellular structure, without regard to the individual cells.

2. Gas diffusion through the cuticle.

Experiments on the diffusion of carbon dioxide through the cuticle are interesting in relation to the gas nutrition of the plant, and have an even greater value as aids in the explanation of the most fundamental physical processes. For we are almost obliged to preface our treatment of osmosis with a rehearsal of the mechanical theory of gases: and then we are too apt to introduce into the particular explanation of osmosis a new element, in the semi-permeable membrane. The plant cuticle is an appropriate instance of a membrane nearly semi-permeable to gases. With the leaves usually employed the experiment is very slow, and I have tested a number of leaves in search of some one with which the course of the experiment would be enough more rapid to recommend it for class demonstration.

All the leaves in the following lot have the stomata confined to the lower surface, and are available for winter use. They were set up in the usual way: a cork fitted over one end of a glass tube, and heated in paraffin, and the leaf sealed over the hole in the middle of the cork. On each leaf all except an area of $121^{\text{sq mm}}$ over the hole was covered with paraffin. Of course it was necessary to have the upper surface of the leaf exposed, instead of placing it next the cork, as Detmer recommends for single experiments. The tubes, all 21^{cm} in length, were then filled with mercury, which was displaced in a mercury bath with carbonic acid. As only a comparison was sought, barometric readings were neglected: the temperature was reasonably constant. All were in the same mercury bath. The experiment began January 8. The height of the mercury column under the various leaves was as follows:

	Jan. 9, 1 P.M.	Jan. 10, 1 P.M.	Jan. 11, 3 P.M.	Jan. 12, 4 P.M.	Jan. 13, 3 P.M.	Jan. 15, 3 P.M.	Jan. 17, 4 P.M.	Jan. 20, 3 P.M.
Ficus (immature)	21^{mm}	26^{mm}	35^{mm}	42^{mm}	46^{mm}	58^{mm}	66^{mm}	73^{mm}
Begonia: smooth, green	18	—	30	36	36	37	43	44
Begonia: red	31	ruptured						
Hedera	27	leaked						
Cyclamen	38	61	90	110	120	140	158	184
Farfugum	34	56	70	98	118	145	157	170
"Croton" (Codiaeum)	65	123	153	168	177	184	185	184

The see-sawing, especially evident with the Cyclamen and Farfugum leaves, is a mystery. From other experiments I know that diffusion through the Hedera leaf is considerably faster than through mature leaves of Ficus. Nerium leaves are also among the more resistant. The resistance to diffusion increases with the age of the leaf and with its dryness. According to Detmer dry Hedera leaves are impermeable; but air dry and entirely brown leaves of Ficus still permit a slow escape of CO_2. From these and a few other experiments I regard the Croton[1] leaf as the best adapted of the leaves of ordinary greenhouse plants for the demonstration within a reasonable time of the diffusion of gases through the cuticle.

What the actual process of the passage of any gas through the cuticle is would be hard to determine. Of course it is not mere diffusion, else the oxygen and nitrogen of the atmosphere would pass more rapidly than the heavier carbonic acid. It may be that they dissolve in the cuticle, the carbon dioxide much more readily: or possibly they enter into some loose chemical combination, as oxygen is taken up and given off by haemoglobin. However that is, the fact that it was under the same leaf that the mercury rose fastest, and began to fall first is probably due to its thin cuticle, so that any gas must traverse it but a short distance. And in any case the external factors governing the rate of passage would be the same.

If it is desired merely to show how fast carbon dioxide can pass through a plant membrane, without concern as to the immediate application of the experiment to ordinary plant problems, one of the water lilies is a still better subject. It should be fixed with the under surface exposed to the air. With all other conditions the same as in the other experiments, and with part of a leaf of *Nymphæa alba* as the closing membrane, the mercury rose 185^{mm} in four hours! In three days it passed 190^{mm}.

[1] The plants commonly known in greenhouses as Croton are really Codiæum.

Most physical chemists agree that so long as the semi-permeable membrane really allows none of the solute to permeate it any resistance it may offer to the passage of the solvent is without influence upon the osmotic pressure. Ostwald,[2] Speyers,[3] and Pfeffer[4] make the same statement. The argument — and it a perfect one — is, in brief, that the osmotic pressure is the aggregate impact of the molecules of the solute against a medium which they cannot permeate : this medium must contain, and hence be permeable to, the solvent, else the solute could not touch it : but as the solvent has no share in the actual pressure, it is indifferent whether its movement be free, or barely possible. Osmotic pressure, in this sense, is computed from boiling and freezing point determinations : it cannot be directly measured. *The osmotic pressure useful in plant cells*, and the osmotic pressure measured by so-called osmometers, *is not the pressure which the flying molecules of the solute exert against the restraining membrane* (or other medium), *but it is the pressure which this membrane passes along against some other, more resistant medium*, or the solvent in question which is outside it. And this practical, available osmotic pressure depends very largely upon the resistance offered by the membrane to the passage of the solvent. If several osmometers be set up with the same solution, osmosis to take place through equal areas of different membranes, it will be found after a time that the columns of liquid they support are far from equivalent. In each osmometer the height of the column measures the pressure then available for work ; but it may be objected that the experiment is not yet complete.

In a plant all the osmotic pressure which does anything — whether it is to keep the plant fresh and stiff (turgescent), or to absorb water from the soil, or to transport water or food, or to fulfill an usual condition of growth — is the pressure of the protoplasm against the cell wall. If there is an increase in the osmotically active material in the cell sap, *i. e.*, in the pressure of the sap against the vacuole wall, the promptness with which there can be a corresponding increase in the pressure against the cell wall depends on how rapidly water can get into the sap, and this in turn depends, inter alia, upon the resistance the protoplasm offers to its passage; this is very slight, but still must be something. Now in practice the osmotically active matter in the sap varies constantly,[5] and therefore the osmotic pressure available for work does depend constantly upon the ease with which water traverses the semi-permeable membrane.

---

[2] OSTWALD : Solutions 103.

[3] SPEYERS : Text-book of physical chemistry 63.

[4] PFEFFER : Pflanzenphysiologie 1:120 [2 ed.]. Zur Kenntniss der Plasmahaut und der Vacuolen, etc., 302. 1890. "Die Qualität der Haut kann, so lange gelöste Stoffe nicht exosmiren, den osmotischen Druck nicht beeinflussen und meine frühere gegentheilige Annahme, die sich der allgemein verbreiteten Vorstellung anschloss ist demgemäss irrig."

To return to the osmometer: the column of liquid supported rises more slowly in some cases than in others because the membrane offers greater resistance to the movement of water through it. It seems evident to me that, if the osmotic pressure is the only force at work, there will be a certain minimum of pressure below which it would not suffice to put the water in the membrane into motion at all. And in this case the height at which the column finally comes to rest will measure the total impact of the molecules against the membrane *minus* the resistance the membrane offers to the passage of the solvent. Whether the movement of the water in the membrane by its own "living force" will be more inward than outward until the entire theoretical osmotic pressure gets expression in the column supported, I do not know, but doubt it: and anyway that would be by the introduction of another source of energy. Talk is not likely to get far on a subject where there have been no experiments for twenty-three years, but it is about all that we have, pro or contra. So long though as he based his opinions on experiments, Pfeffer thought that the pressure was influenced by the resistance of the membrane. And Krabbe[6] says that at temperatures near the freezing point a state of equilibrium is reached while there is a decided tension between the periphery and axis of a cylinder of live pith submerged in water, because of the resistance to the passage of water through the outer cells.

All these considerations apply equally to the tubes closed by a membrane permeable only to the gases on one side. And the fact that the "Croton" leaf did not keep its lead does not destroy my position, because the inward diffusion of the gases of the atmosphere is a

[5] As by movement of salts or food, formation or hydrolysis of starch, etc. As I found some years ago, the turgor in the leaf of Funaria is regularly higher at night, by the pressure of 0.5 per cent. KNO_3, than it is in the morning.

[6] KRABBE, G.: Jahrb. f. wiss. Bot., **29**: 447. 1896. As the water drawn in by osmosis is held by imbibition in the wall, the experiments on imbibition are valid for osmosis. Review in BOT. GAZ. **23**: 303. 1897.

disturbing element which prevents our seeing just what would happen if the carbon dioxide were the only diffusing gas in the question; it is a case where the membrane permits some of the solute to escape.

The fact that carbon dioxide diffuses more rapidly through a cuticle if the latter is kept moist, shows that water also can pass through it, and, therefore, that in the case of a solute which cannot permeate it, the cuticle would serve as the semi-permeable membrane of an osmometer. I have set one up, using a leaf of Farfugum as the membrane, and 20 per cent. NaCl as the solution inside. It was a week before any endosmosis was apparent, and in three weeks the column rose barely 6^{mm}. I believe that though this cuticle be absolutely impermeable for the salt, such a resistance as it opposes to the water must prevent its use for the accurate measurement of osmosis.—EDWIN BINGHAM COPELAND, *University of West Virginia, Morgantown.*

A NEW SPECIES OF PUCCINIA.

Puccinia Thompsonii, n. sp.—III. Epiphyllous or occasionally amphigenous. Sori scattered, oblong to linear-oblong, $0.25–6^{mm}$ long, reddish to chestnut-brown, erumpent, the ruptured epidermis flanking the sides. Spores oblong-clavate, constricted at the septum; vertex rounded or sometimes obtusely pointed, thickened; base obtusely rounded; epispore rather thin, very smooth, color golden-brown or lighter, $48–68 \times 15–24$. Pedicel slender, hyaline, 1.5–2.5 times the length of the spore.

On *Carex stenolepis* Torr. (*C. Frankii* Kunth). Lebanon, Ind., Mar. 19, 1891, *J. C. Arthur;* Pine Lawn (St. Louis), Mo., spring of 1894, *C. H. Thompson;* Alexandria, Ind., Sept. 23, 1898, *Miss Lillian Snyder;* Greencastle, Ind., Oct. 1898, *L. M. Underwood;* Pine Lawn (St. Louis), Mo., Jan. 2, 1899, *Hume & Thompson.*

This species somewhat resembles *P. Bolleyana* Sacc., but differs from it in the more scattered, larger, oblong, lighter-colored sori and the somewhat longer and narrower spores. The epispore of the upper cell is not quite so much thickened. The species is named for C. H. Thompson, of the Missouri Botanical Garden, who first called my attention to it. In the above description the material from St. Louis is taken as the type, as its abundance has furnished ample material for study. However, the material collected at the several points in Indiana, above cited, shows no appreciable variation. I am indebted